
DTU

Quantification of Ergonomic Stress During Mastoidectomy Training via EMG and ECG analysis

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State of the Art

Ergonomics & WRMDs in Surgery

- High prevalence of neck, shoulder, and back symptoms [1],[2]
- Significant impact on:[1], [2]
  - daily activities
  - career longevity
- Poor awareness of ergonomic recommendations [1], [2]
- Strong need for education and objective assessment [1],[2]

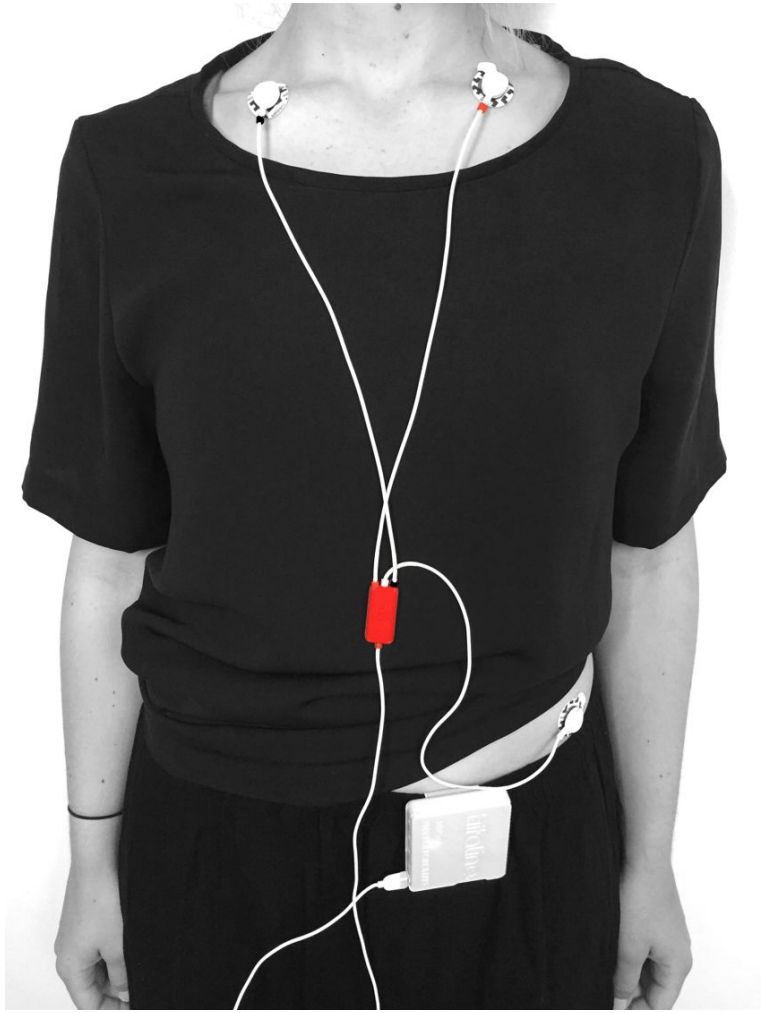
Surgical Visualization Systems

- Traditional operating microscope: [3]
  - excellent visualization
  - poor ergonomics (static posture, neck flexion)
- 3D exoscopes / RoboticScope: [3]
  - decoupled vision and posture
  - improved freedom of movement

[1] Josiane Bolduc-Bégin et al. “Work-related musculoskeletal symptoms amongst Otolaryngologists and Head and Neck surgeons in Canada”. In: European Archives of Oto-Rhino-Laryngology 275.1 (Oct. 2017), pp. 261–267. ISSN: 1434-4726. DOI: 10.1007/s00405-017-4787-1. URL: http://dx.doi.org/10.1007/s00405-017-4787-1.
[2] Sherise Epstein et al. “Prevalence of Work-Related Musculoskeletal Disorders Among Surgeons and Interventionalists: A Systematic Review and Meta-analysis”. In: JAMA Surgery 153.2 (Feb. 2018), e174947. ISSN: 2168-6254. DOI: 10.1001/jamasurg. 2017.4947. URL: http://dx.doi.org/10.1001/jamasurg.2017.4947.
[3] Ankit Ajmera et al. “Ergonomics of 3D-exoscope versus the operating microscope in otologic surgery”. en. In: ANZ J. Surg. 95.9 (Sept. 2025), pp. 1862–1868.

HRV from ECG

- ECG sensor setup tested
- Initial recordings attempted



HRV from ECG

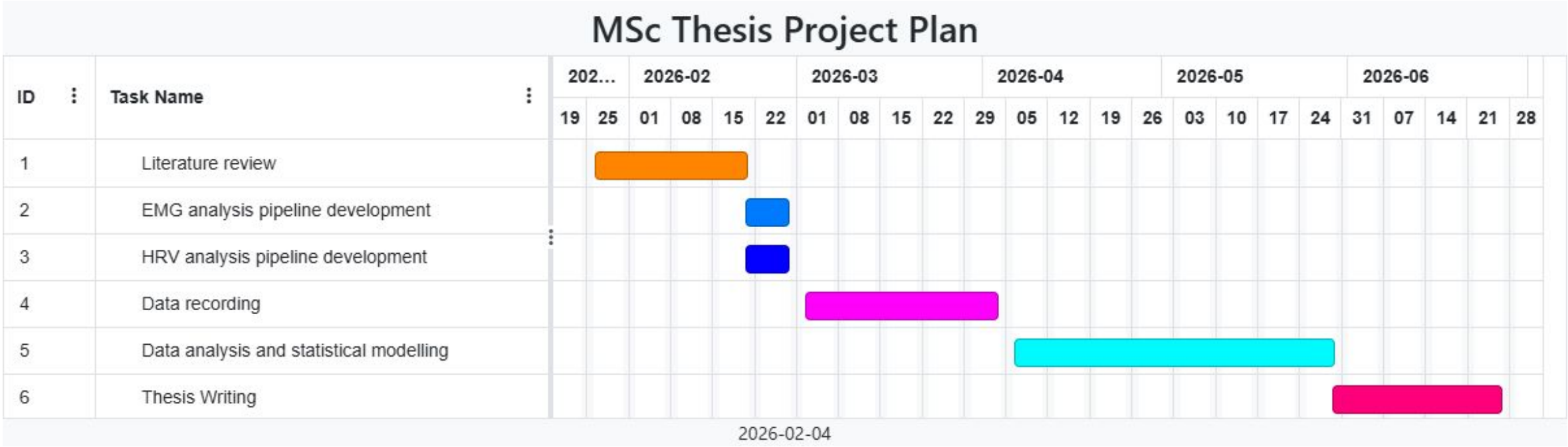
- ECG preprocessing steps: [4], [5]
  - Band-pass filtering to enhance QRS complexes
  - Notch filter
  - R-peak detection (comparison of multiple algorithms)
  - RR interval extraction
  - Artifact detection and ectopic beat removal
  - Interpolation to obtain NN interval series
  - HRV feature extraction (time, frequency, nonlinear domains)

[4] Shaffer, Fred, and J. P. Ginsberg. “An Overview of Heart Rate Variability Metrics and Norms.” *Frontiers in Public Health*, vol. 5, no. 258, 28 Sept. 2017, pmc.ncbi.nlm.nih.gov/articles/PMC5624990/, https://doi.org/10.3389/fpubh.2017.00258.

[5] Benchekroun, Mouna, et al. “Preprocessing Methods for Ambulatory HRV Analysis Based on HRV Distribution, Variability and Characteristics (DVC).” *Sensors*, vol. 22, no. 5, 3 Mar. 2022, p. 1984, https://doi.org/10.3390/s22051984. Accessed 2 May 2022.

Project Plan

- Abstract
- Objectives
- Expected Outcomes
- Supervision and Organisation (Gantt chart)



Next Steps

Continue literature review → Finish ECG (HRV) pipeline → Research on EMG